Megacephalon maleo. The reviewer corrects, by the way, my calling the Celebean whimbrel *Numenius phæopus*, saying that it is probably *N. uropygialis*, but these two names are synonymical, cf. for instance, Salvadori, *Orn. Pap.*, iii., 332, 1882, *sub N. variegatus*. As to its nesting on small trees "small brushes" were intended to be implied (see Legge, "Birds of Ceylon," 1880, p. 913).

A. B. MEYER.

Royal Zoological Museum, Dresden, March 22.

Crystals of Lime.

IT was pointed out to me by Mr. W. J. Pope, of the City and Guilds of London Institute, that a lime cylinder which had been used in the lantern during a lecture had become distinctly crystalline where affected by the oxyhydrogen flame.

Examined under the microscope by polarized light, the crystals are seen to be well-defined cubes with striated faces. When immersed in water they break up and give rise to minute doubly refracting plates of rhombic outline, behaving in this respect like ordinary lime; the cubic crystals, however, are less rapidly affected by exposure either to air or water than is amorphous lime.

Lime is commonly stated to be infusible at the temperature of the oxyhydrogen blow-pipe; and the only crystals previously recorded, so far as I know, are those obtained by Brügelmann, by fusing calcium nitrate (*Annalen der Physik und Chemie*, ii. p. 466, iv. p. 277, 1877–78). It seems, therefore, worthy of notice that they are possibly always formed upon the surface of the lime cylinders by the action of the oxyhydrogen flame.

The crystals resemble in all respects those described by Brügelmann. The jet used on the present occasion was an ordinary blow-through jet.

H. A. MIERS.

Foreign Substances attached to Crabs.

I AM glad to see that Mr. Garstang agrees with me in regarding the presence of the Ascidians on *Hyas* as accidental.

I had no intention of decrying the value of Mr. Garstang's experiments with Ascidians, but his rule might, perhaps, be limited to those members of the group to which it can be proved to apply. Under natural conditions it apparently fails to apply to *P. corrugata* and *M. arenosa*. As to the latter, Prof. McIntosh assures me that he has frequently found it in the stomach of the cod and haddock.

The appreciation of the cod for *A. mesembryanthemum* is, I think, sufficiently proved by the fact that the latter is one of the most successful cod-baits used here.

ERNEST W. L. HOLT.

St. Andrews Marine Laboratory, March 29.

Wimshurst Machine and Hertz's Vibrator.

IT may interest those who wish to repeat Hertz's experiments on electro-magnetic radiation to know that many of these can be done very well by using a small Wimshurst machine in place of the usual induction coil and battery. The vibrator and resonator which we used were like those described in NATURE (vol. xxxix. p. 548), and the Wimshurst machine had two 12-inch plates (giving at most with the jars on a 4-inch spark). The wires from the vibrator, instead of being connected with an induction coil, were connected with the two outer coatings of the jars of the machine. The machine spark-gap and the vibrator spark-gap should be so adjusted that when a spark occurs at the former one also occurs at the latter. With the apparatus described we got good results when the spark-gaps were 38 mm. and 3 mm. respectively. The outer coatings of the jars are only connected together by the wood of the machine, but it is sometimes an advantage to put a few inches of damp string between the balls of the vibrator.

This combination is obviously a modification, adapted to work a Hertz vibrator, of one of Dr. Lodge's well-known Leyden jar arrangements.

No doubt many persons have connected the vibrator directly with the terminals of the machine, but this arrangement does not work nearly so well.

T. A. GARRETT.
W. LUCAS.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE annual meeting of the Institution of Naval Architects was held under the presidency of Lord Ravensworth, on Wednesday, Thursday, and Friday of last week. There was a fair list of papers on the programme, although at one time, shortly before the meeting, it was feared that there would be a sad lack of contributions from members. At the last minute, however, one or two papers came in, and the list, although perhaps below the average in the importance of the memoirs. was of passable interest.

The following is a consecutive enumeration of the business that was transacted at the meeting:—

Wednesday, March 26th: morning sitting—Annual Report of the Council, and other routine business; Address by the President. Paper read and discussed—Notes on the recent naval manœuvres, by Mr. W. H. White, F.R.S., Director of Naval Construction.

Thursday, March 27th: morning sitting—The Maritime Conference, by Rear-Admiral P. H. Colomb; strength of ships, with special reference to distribution of shearing stress over transverse section, by Prof. P. Jenkins; steatite as a pigment for anti-corrosive paints, by Mr. F. C. Goodall. Evening sitting—On the evaporative efficiency of boilers, by Mr. C. E. Stromeyer; on the application of a system of combined steam and hydraulic machinery to the loading, discharging, and steering of steam-ships, by Mr. A. B. Brown; the revolving engine applied on ship-board, by Mr. Arthur Rigg.

Friday, March 28th: morning sitting—On leak stopping in steel ships, by Captain C. C. Penrose Fitzgerald, R.N.; on the variation of stresses on vessels at sea due to wave motion, by Mr. T. C. Read; spontaneous combustion in coal ships, by Prof. Vivian Lewes. Evening sitting—Experiments with life-boat models, by Mr. J. Corbett; on the screw propeller, by Mr. James Howden.

The annual dinner was held on the evening of Wednesday.

Out of the above list of a dozen papers there were fewer than usual of scientific interest, and, indeed, in one or two instances they were not either distinguished by practical interest. Mr. White's paper, which formed the *pièce de resistance* of the meeting, was of military rather than scientific importance, and was chiefly notable from the number of admirals that took part in the discussion; indeed, the whole naval contingent of the Board of Admiralty was present to hear the paper read. Admiral Colomb's paper on the recent Washington Maritime Conference was practically reduced to a consideration of the rule of the road at sea. The general opinion of the authorities assembled appeared to be that the present rule of the road is very well as it stands, with the exception that the "holding-on ship" should not be required, or even allowed, to slacken her speed. This seems in conformity with common-sense. If two ships are converging towards a point, say at right angles to each other, and one shifts her helm to go under the other's stern, if the second, or holding-on ship, slacken speed, the probability will be that the giving-way ship will crash into the other's broadside or cross her bows; in the latter case, there is probability that the holding-on ship will give the other her stem. What is most wanted when danger of collision arises, is certainty on each vessel as to what the other may be going to do. If the holding-on ship never slacken speed—is not allowed to slacken speed—then the other vessel knows exactly what course to take; as the law stands, the quartermaster, or officer in charge, is never quite sure until the last minute, especially at night, whether the other ship considers there is danger of collision or not, and, therefore, whether she will slacken or keep to full speed. We anticipate the proposed alteration, if put in force, will greatly lessen the list of collisions.

The memoir contributed by Prof. Jenkins on the strength of ships was decidedly the most important contribution to naval science of this year's meeting. The paper will open up to the majority of those practically engaged in the design of ships a new field of research, the investigation of which will enable them to solve some problems which have hitherto been without explanation. That is, speaking generally—for the influence of longitudinal bending moment on shearing stress has before been investigated by naval architects; notably by Mr. W. H. White, the Director of Naval Construction, and Mr. W. John. This, however, was many years ago, and in connection with wooden ships with no longitudinal connection between the planking except that supplied by dowells, the friction of the edges, and the "anchor-stock" shape of the pieces. It will be evident, therefore, that previous investigations must have been of a qualitative, rather than of a quantitative, form; and the world of naval architecture is much indebted to the occupant of the John Elder Chair at Glasgow for putting the problem on a practical quantitative basis.

The paper contributed by Mr. C. E. Stromeyer had a most attractive title, "The Evaporative Efficiency of Boilers"; and a good many of the working marine engineer members of the Institution, who were acquainted with the thorough manner in which the author follows up all his work, had assembled to hear the paper read, and take part in the discussion. We are afraid it must have been somewhat of a disappointment to several of these gentlemen when they turned over the leaves of the paper as it was placed in their hands, and found that the matter was rather of a suggestive than of a conclusive character. There is so much business to be crowded into the three days' annual meeting of this Institution that it is necessary the papers should be read with despatch; and we quite sympathize with the engineer whose daily task is of an administrative rather than a contemplative nature, when he is asked to assimilate at a galloping pace two or three pages of mathematical formulæ of by no means an every-day character.

Mr. Stromeyer confined himself chiefly to a consideration of the relative distribution of efficiency in the tubes. He points out that the distribution is governed partly by the temperatures in the combustion-chamber and smoke box, and partly by the resistance of gas in the tubes, and this again depends upon the velocity and temperature of the gas, and on the loss of heat experienced by it. Mr. Longridge has found that the coefficient of transmission of heat through boiler-tubes or combustion-chamber plates is eleven calories of heat per square foot per hour for every degree F. of difference between the gas and the water: 0·091 is the reciprocal value, and is the resistance offered to the flow of heat under the above condition. This resistance is offered when heat passes from one medium to another, as, for instance, from the gas to the metal, from the metal to the boiler scale, or to the water, and it also includes the resistance offered by the metal to the scale. For iron and boiler scale the resistances are 0·00202 and 0·207 per inch thickness; so that a clean ½-inch plate would offer 0·001 resistance; or, if covered with scale one-tenth inch thick, the resistance would be $0·001 + 0·021 = 0·022$.

Arguing from these facts the author concludes that the chief resistance, about 80 per cent., is encountered at the surfaces; and he doubts whether the change of medium from iron to scale, and to water, influences the values very much. The chief difficulty in transmitting heat from the gas to the tubes is want of circulation, or admixture of gas in the tubes. He speaks favourably of draught retarders, corrugated tubes, and ribbed-tubes for the purpose.

Mr. Stromeyer next refers to the experiments of Haverez (see *Ann. du Génie Civil*, 1874), by whom it was shown that more heat is absorbed in the fire-box with flaming material than with flameless coke. It is well known that a luminous flame radiates more heat than one which is non-luminous; and it is for this reason that the latter may not be used in the Siemens-Martin furnace. For reasons given, Mr. Stromeyer would prefer that, in the formulæ used by Mr. Longridge for heating boiler tubes, the coefficient of resistance $\frac{1}{m}$ should be somewhat increased; say from 0·091 to 0·1. This the author works out in detail. We have stripped Mr. Stromeyer's arguments of their mathematical aspect, as, however interesting the matter may be, we have not space to do it justice. We must refer those of our readers who are sufficiently interested in the subject to the Transactions of the Institution.

Mr. Macfarlane Gray, of the Board of Trade, was the chief speaker in the discussion which followed. He said he could not pretend at one reading to follow the author in all his reasoning. Mr. Fothergill, who is the superintending engineer to a north country line of steamers, gave the meeting the benefit of his practical knowledge upon the subject. Mr. Fothergill is well qualified to speak on the question of the evaporative efficiency of marine boilers, as he has made an especial study of the matter in the actual working of vessels in connection with his well-known researches on the subject of forced draught on ship-board.

Mr. Brown's paper was one of unusual interest to the members of the Institution. In it he described the most recent development of that beautiful system by which he has so vastly improved the loading and discharging of cargo on steam-ships, and the steering of vessels. The paper was illustrated by several diagrams without the aid of which it would be impossible to make clear the details of the very ingenious methods by which the author has applied his combined steam and hydraulic practice to the purposes named. Briefly stated, it may be said that, in place of the usual deck winches, there is placed at every hatch a derrick, having mounted upon it the hydraulic cylinder which supplies the motive power to lift the goods. The steering motor is placed directly on the quadrant of the tiller, and is actuated from the bridge by means of what the author describes as a telemotor. The transmission of the controlling force which governs the steering motor is through hydraulic pipes; a vast improvement on the rattling chains and rods now in common use. In fact the great virtue of Mr. Brown's system is its quiet working.

Mr. A. Rigg's revolving engine is an ingenious device, perhaps better suited to water than steam. It was fully described in Section G at the last Birmingham meeting of the British Association.

"Leak Stopping in Steel Ships" was the somewhat misleading title of a rather weak paper by Captain Fitzgerald. The only point the author suggested was that war-ships should be outside sheathed with wood in order that there might be some attachment to which leak stoppers could be affixed. The contention that the swelling of wood by moisture that takes place, or used to take place, when a shot cut through the side of an old man-of-war is quite beside the mark, as we suppose no one proposes to make the wood sheathing of a modern steel steamer as thick as the sides of our old wooden walls. Three or four inches of elm would do very little swelling when pierced by a modern projectile of any considerable size.

Mr. T. C. Read's paper on the variation of stresses at sea is another of those contributions which are the despair of the practical naval architect, not over-given to abstruse science, who attends the meetings of his Institution, hoping to take part in the discussions. We are quite at one with the speaker, Mr. Alexander Taylor, who proposed that a rule should be passed compelling contributors to send in their papers sufficiently early for them to be printed and distributed to members before the meetings. The executive say it cannot be done, but it would be worth trying for a time.

Prof. Lewes's paper on the ignition of coal cargoes was quite a new departure in the practice of the Institution. When the members assembled they found an array of bottles, flasks, and chemical apparatus, that was not a little puzzling to those not in the secret, and must have reminded many of the dear old Polytechnic days and Prof. Pepper. However, the lecture, and the experiments by which it was illustrated, were of a thoroughly sound and practical nature. The question of spontaneous ignition of coal cargoes is one for the ship-owner rather than the ship-builder; excepting that ship-builders have to replace the vessels which are destroyed by reason of such spontaneous ignition. The lecturer illustrated the influence of carbon in producing heating by the power it possesses of attracting and condensing gases upon its surface. The action of the bituminous constituents of the coal in spontaneous ignition was next dealt with, and the author then proceeded to point out the important part the action of iron disulphide, pyrites, or coal-brasses played in promoting spontaneous ignition. The remedy Prof. Lewes advises for the evils of spontaneous ignition are: firstly, non-ventilation of holds, so that oxygen may not be admitted to carry on the chemical processes by which heat is generated; secondly, by placing thermometers, suitably protected, in the mass of coal, so that, by electrical communication, warning may be given when the temperature rises to a dangerous point; and, thirdly, by placing flasks of liquid carbonic anhydride in the coals, the flasks to be sealed by an alloy with a low melting-point. This would be fused when the dangerous temperature was reached, and the carbonic acid, in expanding to its gaseous state, would cool the mass of coal to a safe temperature.

At the last sitting of the meeting, Mr. Corbett's paper on lifeboat models raised a lively controversy. The Royal National Lifeboat Institution had brought Mr. G. L. Watson all the way from Glasgow to meet the bold innovator who proposed to abolish their cherished self-righting boats. Of course, who is right remained an open question, as it always does when the properties of lifeboats are concerned.

Mr. Howden's paper on the screw propeller was of great length, containing no less than twenty-four pages without the appendix. Mr. Howden, like many other people, has a theory of his own on the screw propeller, which is opposed to that of all other authorities on the subject; for he believes that Rankine, Froude, Cotterill, and others, have based their conclusions on erroneous premises. It will be evident that we cannot enter into this vast subject at the end of a notice such as this, but we may briefly record our opinion that the older authorities were right.

On the whole, the meeting passed off very well. The attendance was good, and Mr. Holmes, the secretary, had made his arrangements so that the business proceeded without a hitch, as, indeed, is invariably the case at this well-managed institution.

BOURDON'S PRESSURE GAUGE.

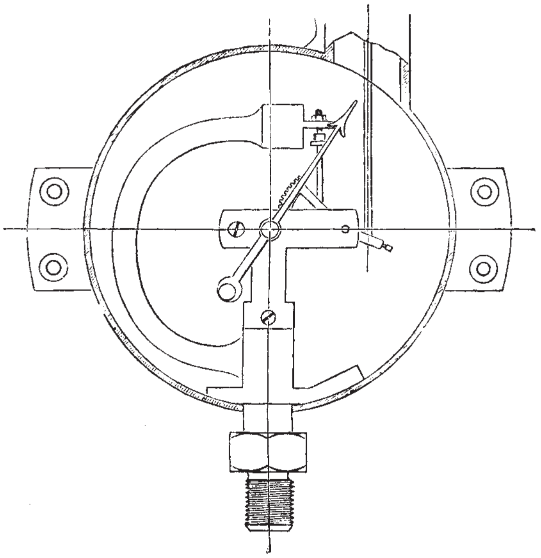
MR. WORTHINGTON'S letter to NATURE, January 30 (p. 296), on the theory of this instrument, has excited some criticism and disagreement of opinion; so it is proposed to examine here how far it is possible to construct a theory which shall be quantitative, in addition to giving a general explanation of the action.

The instrument is in very extensive use, hardly a steam-boiler being in existence which is not provided with one; and the simplicity and strength of the construction are such that it does not easily get out of repair, while it can be made to register either the highest pressure of the hydraulic press, or to record in the form of a barometer the minute fluctuations of atmospheric pressure.

The principle of the instrument was discovered by accident, and the account of this had best be given in the inventor's own words, taken from the paper read by him before the Institution of Civil Engineers, printed in the Proceedings I.C.E., vol. xi., p. 14, 1851:—

"The author had occasion to construct a worm-pipe for a still, by bending a cylindrical tube into a spiral or helical form. The workman performed the operation awkwardly, and partially flattened a considerable portion of the tube. In order to restore its form, one end was closed and the other was connected with a force-pump, by which water was forced into the tube; as the flattened portion of the tube resumed its cylindrical form, it was observed that the spiral uncoiled itself to a certain extent, and it was immediately perceived that this action might be applied to the construction of a pressure gauge."

To construct, then, a Bourdon gauge to register high pressures (*vide* figure, representing a gauge fitted to an indicator, not shown) a steel tube bored out of the solid bar to the requisite thickness for strength is taken, and purposely flattened, and then bent round into the arc of a circle so that the longer axis of a cross-section stands at right angles to the plane of the circle: one end of the tube is screwed to a pipe which communicates with the liquid whose pressure is to be measured, while the other end is closed and joined by levers and racks to a shaft and a pointer, which traverses a dial on a box in which the curved tube is enclosed.



As the pressure in the tube is increased, the circular axis uncoils into a larger circle of smaller curvature, and the corresponding indications of the pointer on the dial are marked; and thus the instrument is graduated empirically by reference to some standard pressure gauge. As the pressure is again diminished, the elasticity of the tube brings it back to its original form, and the pointer retraverses the dial.

Lord Rayleigh gives an elementary explanation of the action of Bourdon's gauge in the Proc. Royal Society, No. 274, December 13, 1888; treating the movement of the walls of the tube as one of pure bending, he says:—

"In this instrument there is a tube whose axis lies along an arc of a circle and whose section is elliptical, the longer axis of the ellipse being perpendicular to the general plane of the tube. If we now consider the curvature at points which lie upon the axial section, we learn from Gauss's theorem (that in the bending without stretching of an inextensible surface, the